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Upon establishment of the St. Louis Junior College District, it was decided to make use of computer simulation facilities of a nearby aero-space contractor to develop a master schedule for facility planning purposes. Projected enrollments and course offerings were programmed with idealized student-teacher ratios to project facility needs. In comparing numbers of classrooms and laboratories needed from studies of current scheduling practices in other states, the computer simulation indicated one-third less instructional facilities were needed. This high facility utilization produced through computer simulation saved about $3,000,000 in building costs for one campus. The computer study cost $15,000. Analysis standards and methods used in the computer scheduling program GASP are described. (RP)

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Flying A College On The Computer

(The Use Of The Computer In Planning Buildings)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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FLYING A COLLEGE ON THE COMPUTER

An enormous investment in physical plant is foreseen in the coming years with the tremendous increase in enrollments approaching higher education. Some prognosticators have predicted the doubling in the next decade of the physical plant built during the last 300 years. The dollars that would be needed are astronomical. The basic assumption is that the utilization of buildings will be much the same in the future. In many cases this has been only 30 - 50% of the week from 8:00 AM to 5:00 PM- Monday through Friday.

Any significant increase in the percentage of utilization could materially reduce the needed financial outlays. In the belief that the public is going to demand greater utilization of the educational plant, various plans of year-around operation, cooperative education and study abroad have been introduced. But most of these avoid the method offering the greatest potential of serving increased enrollments with the least expansion of the current buildings or the construction of new buildings or colleges. That is, increasing the utilization of current and new buildings planned.

At this point the challenging of any figures should be encouraged - others or ours. For example, one of our three architectural firms was told by a junior college representative that they used their plant 60% to 80% of the day. We asked for the figures and after careful analysis noted the omission of 23 educational spaces such as a small theatre, nine music rooms, pool, field house and other educational areas in their computations. Also, it is interesting to note how the time was selected for the 45-hour week. Quoting from the report:

> "Column 5 indicates the percentage of use based on a 45-hour week. This denominator was selected because it includes the most common hours in which classes are scheduled, i.e., from 8:00 AM to 3:00 PM, Monday through Friday (excluding the 11:00 AM on Tuesday and Thursday) and from 6:30 to 9:30 P M Monday through Thursday."

Of course with this kind of selection of hours a high utilization could be shown. But computing the use as we do in this study from 8:00 AM to 5:00 PM, Monday through Friday, the results are quite different. The classrooms were utilized 46.3% and laboratories and other special spaces 44.7% of this 45-hour week. One humanities and one social science lecture room were used 80% as well as one natural science laboratory.

In planning three new junior college campuses in Saint Louis for about 15,000 students in the early 1970's, we assumed the public would be interested in the least possible cost and thus demand every possible utilization of space throughout the year. After careful study the District adopted year-around operation on a trimester schedule. Because of a long and intimate knowledge

of junior college planning in California, a recent study[1] was used as an initial bench mark.

After a careful examination of this study, we projected the plans for our first campus for 4,500 full-time day students at 80% utilization of classrooms and 60% utilization of laboratories from 8:00 AM to 5:00 PM - Monday through Friday. Also, a variety of room sizes was planned to increase seat utilization. In line with the practice of many community colleges in other parts of the country, we knew the evening hours would have nearly 100% utilization by adults in the continuing education program.

Our architects checked the proposed number of classrooms with norms and studies of current practice and indicated we had one-third less rooms than these guides would indicate. While this raised concern, a careful review of the method of determining the number of rooms by various sizes and uses re-affirmed our judgment that this was possible.

During this time we had been working with the McDonnell Automation Center, a division of the McDonnell Company, the prime contractor for the Mercury and Gemini programs and the F4h fighter used by all three of the military services. They told of simulating the fighter on the electronic computer and "flying" it many times, with major and minor changes made between each "flight". We asked, "Why not fly a college on the computer?"-- And we were off on the computer simulation of our Meramec Community College, one of the three proposed campuses in the Junior College District.

It was not an easy problem, even for the experts who had simulated the Mercury on many orbits before it ever left the ground. What was needed was a master schedule for the operation of the campus and this had not been done before on the computer. A request to Dr. Harold Gores, President of the Education Facilities Laboratories, initiated contact with Robert Holz of the Massachusetts Institute of Technology, who had just finished a new computer program that could build a master schedule.

Subsequent discussions indicated Holz's GASP (Generalized Academic Simulated Program) would work, McDonnell had the 7094 computer and expert personnel to prepare and run the program, and EFL agreed to finance a pilot study.

Briefly, the programs for 4,500 students (60% in college transfer and 40% in technical programs), number and size of rooms planned, faculty proposed, and various time patterns were the input data. In approximately five minutes the

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[1] A PRELIMINARY REPORT ON THE APPLICATION OF THE SPACE ADEQUACY SURVEY-COLLEGE AT SEVENTEEN SELECTED CALIFORNIA JUNIOR COLLEGES, J. C. Portugal, Field Service Center, University of California, 1961.

computer could go through the thousands of combinations possible and start the printing of a schedule. Twenty-five (25) minutes later the room utilization, including each faculty member's schedule, each student scheduled, the percent of rooms used, the percent of seats utilized, and other pertinent information covering some 100 pages was available for analysis.

WE HAD PLANNED OUR COLLEGE - WHICH HAD NOT BEEN DESIGNED AS YET - FOR OPTIMAL USE!

After a review of the utilization we would add a lecture hall, take out unused classrooms, vary the number of faculty, etc., and make another run. We did this some 27 times. A detailed report[2] is available with considerable technical data that cannot be included here.

In comparison with three colleges of similar size in California, our original figures and those computed by the simulation indicate the potential savings in building construction.

TABLE 1 - COMPARISON OF INITIAL ESTIMATES, COMPUTER PROJECTIONS WITH THREE JUNIOR COLLEGES OF SIMILAR SIZE

Type of Rooms	A*	B*	C*	Initial Estimate	Computer
Standard Classroom	84	63	82	38	37
Large Lecture Halls	1	5	5	5	6
Special Class & Shop	33	38	21	7	15
Laboratories	23	30	41	42	22
Total **	141	136	149	92	80

* - Op. Cit. - Portugal
** - Physical Education omitted in all listings

After a final review we provided our architects with the educational specifications for 85 educational spaces--seven less than they had not thought possible earlier. But now by computer simulation we had shown it was possible.

[2] ROOM UTILIZATION AT THE MERAMEC COMMUNITY COLLEGE - A Report to the Junior College District, St. Louis-St. Louis County, Missouri, McDonnell Automation Center, Box 516, St. Louis, Missouri - January 1964.

A, B, and C colleges in Table 1 average 142 rooms and thus this computer study indicated a need for 62 fewer rooms. While there are various ways to compute the possible savings, the results indicated a reduction of approximately 100,000 square feet of educational space. With the added service space and mechanical services needed to support these 62 educational spaces our reduction of building costs at $20.00 per square foot could be in the order of $2,500,000 to $3,000,000. You can draw your own implications as to the meaning if applied on any large scale. And for the investment--our study cost less than $15,000 -- the potential savings are enormous.

From the outset we had been concerned about seat utilization as well as room utilization. If 25 students were in a room furnished for 50 students, this would be 100% utilization of that room for that hour but only 50% seat utilization. Thus, in each of the 27 runs we changed the size of some rooms and ended with three classroom sizes (for 24, 35 and 50 students) and three lecture hall sizes (for 100, 150 and 320). In this way we had 82% utilization of the classrooms and 66% utilization of laboratories used. It was shown by use of the computer that all the programs could be scheduled in only 75 rooms with 88% seat utilization.

Since experience and judgment must be added to the computer results, we kept the music and journalism rooms, reading, office machine and microbiology laboratories even though the results show very limited use, since only formal class activities were included for a fall session in the input data. Experience tells us we will have music, reading and journalism programs although not as formal class activities. Judgment tells us we must offer microbiology and office machine in the fall session, in addition to the spring and summer. But including all these we have 68% room utilization and 60% seat utilization.

Table II shows the number of rooms available, number used in Run #27, and percentage of room and seat utilization for the total rooms and the minimum number needed. (See following page.)

Normally, the greatest costs of operation once the plant is constructed are the instructional costs, and specifically, faculty salaries. By changing time patterns and instructional methods from run to run, we found different ways to distribute the faculty. Table III shows how we arrived at a need for faculty and refinement by the 27 "flights" on the computer which gave the exact number needed by field. The total of 173 gives a student-faculty ratio of 26 to 1. This could have many meanings and is the subject of a much more extensive study on the use of instructional resources. We are pursuing this currently and hope to be able to report on some of our findings in the not too far distant future. We might indicate we have acquired an affection for the computer and it is much in our plans as a part of our instructional resources as an aid to the teacher.

TABLE II - SUMMARY OF ROOM AND SEAT UTILIZATION

Run No. 27

Room Type	Total Rooms	No. Used	Total Rms.	Used Rms.	Ave. Seat* Util/45 Hour Week Total Rms.	Ave. Seat Util/Class Used Rms.
A24 (Clssrm)	19	19	96%	96%	86%	90%
B35 (Clssrm)	16	15	61	65	51	84
C50 (Clssrm)	2	1	31	62	23	73
D100 (Lec. Hall)	4	4	94	94	84	89
E150 (Lec. Hall)	1	1	77	77	62	81
F320 (Lec. Hall)	1	1	57	57	45	79
G25 (Art Studio)	3	2	56	84	45	82
H100 (Music Hall)	1	1	9	9	4	42
132ZO (Zoo. Lab.)	1	1	33	33	25	78
132B1(Bio. Lab.)	2	2	67	67	65	96
132MC (Microb. Lab.)	1	0	0	-	0	-
132AB (Anat. Lab.)	1	1	13	13	11	83
J32CM (Chem. Lab.)	6	5	69	83	63	91
J32GY (Geol. Lab)	1	1	48	48	38	80
J32PY (Phy. Lab.)	3	2	48	73	48	99
K32ED (Eng. Drwg.)	4	4	86	86	83	95
L25 (Jour. Lab.)	1	0	0	-	0	-
M20 (Read. Lab.)	1	1	9	9	9	100
N35 (Acctg. Lab.)	2	1	50	100	49	98
O35 (Typg. Lab.)	3	3	74	74	64	86
P25 (Ofc. Mach. Lab.)	1	0	0	-	0	-
Q24NA (Nurs. Lab.)	1	1	35	35	30	83
Q25DA (Dent. Lab.)	1	1	93	93	93	100
Q24ET (Eng. T. Lab.)	3	3	58	58	42	73
R50 (Lang. Lab.)	1	1	80	80	65	82
S30 (P.E. Space)	5	4	70	87	69	99
All Clssrms.	37	35	78	82	67	87
All Lec. Halls.	6	6	86	86	74	86
All Science Labs	15	12	53	66	48	91
All Others	27	22	59	72	52	88
All Rooms	85	75	68	77	60	88

*This column is used seat-periods divided by available seat-periods.

TABLE III - INITIAL AND FINAL FACULTY REQUIREMENTS

Subject Group	Estimated No. of Faculty	Computer Results No. of Faculty	Remarks
English	16	26	Any English Course
Speech	3	3	Any Speech course; also English
Foreign Language	15	22	7 French, 9 Spanish, 6 German
Mathematics	13	17	Any Mathematics
Social Science	23	22	2 Economics, 1 Political Science, 2 Sociology, 2 Psychology, 3 History, 12 Social Science, Recitation
Journalism	1	1	Also English
Reading	1	1	Also English
Art	5	5	Studio or Appreciation
Music	4	4	Activities or Appreciation
Physical Education	10	9	6 men; 3 women
Accounting	3	3	1 also Secry. 1 also Bus. Ad.
Typing-Shorthand	7	5	Either
Bus. Administration	3	3	Academic Business
Life Science	11	7	Lecture or Lab.
Physical Science	20	20	12 Chemistry, 6 Physics, 2 Geology
Engineering	6	10	Drawing or Courses
Technical	20	15	3 Nursing, 3 LPN, 3 Eng. Tech., 3 Dental Asst., 1 Law Enforcement, 2 Tech. Bus.
Total	161	173	

SUMMARY

In planning a campus for 4,500 full-time day students the assumption was made that classrooms could be utilized 80% and laboratories 60% of the day. From a study made in California the number and type of rooms needed with this assumption was developed. Since the results yielded a number considerably less than most colleges constructed and planned for this approximate size, a check was needed. After investigation it was determined that a new computer program could construct a master schedule and "fly the college" as if in actual operation.

In addition to room utilization, seat utilization had to be considered, for high room utilization would not necessarily bring high seat utilization.

The 7094 computer at McDonnell Automation Center was used with the GASP program developed by Robert Holz of M.I.T. The final results were in summary as follows:

Room	Total	Used	Room Utilization Total	Room Utilization Used	Seat Utilization Total	Seat Utilization Used
Classrooms	37	35	78%	82%	67%	87%
Lecture Halls	6	6	86	86	74	86
Science Labs	15	12	53	66	48	91
All Others	27	22	59	72	52	88
Total Rooms	85	75	68	77	60	88

In addition to proving that the desired utilization for each type of room could be obtained within the proposed master plan, it was shown how the master plan could best be modified. Conservatively this could mean a saving of $3,000,000 on this one campus. Other studies, we believe, will convirm that such high utilization is possible -- particularly with the use of the computer as a check in the development of a master schedule for planning and actual operation.

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